Nationaal Lucht- en Ruimtevaartlaboratorium
National Aerospace Laboratory NLR

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NLR contribution to the PLANET newsletter

R.R. Seljée and H.H. Hesselink

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This report is based on an article that appeared in the PLANET newsletter, published by the European Network of Excellence on AI Planning.

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Summary

"AI Planning is a key enabling technology for intelligent systems. It increases the autonomy, flexibility, and robustness for a wide variety of application systems. These include web-based information and e-commerce systems, autonomous virtual and physical agents, and systems for the design and monitoring of production, management, and business processes. PLANET is the European coordinating organisation for research and development in the field of AI Planning and Scheduling. It aims to stimulate innovative research and development and to promote the industrial uptake of the technology" (mission statement of PLANET).

PLANET publishes on a regular basis a newsletter that informs their community about recent and ongoing activities of the network. The NLR has contributed in the third issue of their newsletter by an article about planning activities at NLR. The content of this article is presented in this document.

Contents

List of Acronyms

AATMS
Airborne Air Traffic Management System

AIRPORT-G
Airport Integrated Research & development Project for Operational Regulation of Traffic-Guidance

ATC
Air Traffic Control

ATM
Air Traffic Management

BETA
operational Benefit Evaluation by Testing an A-SMGCS

CDM
Collaborative Decision Making

DAVINCI
Departure and Arrival Integrated Management System for Co-operative Improvement of Airport Traffic Flow

LEONARDO
Linking Existing ON ground Arrival and Departure Operations

PHARE
Programme for Harmonised Air traffic management Research in Eurocontrol

PLANET
european NETwork of excellence in AI PLAnning

MADS
MANTEA Departure Sequencer

MANTEA
Management of Surface Traffic in European Airports

SID
Standard Instrument Departure

TCU
Technical Coordination Unit

1 Introduction

With the start of PLANET-II, the National Aerospace Laboratory NLR joined the network. NLR is a member of the Aerospace Applications TCU. In the years before, NLR already attended several PLANET workshops and conferences.

NLR is the central institute for aerospace research in the Netherlands. Since 1937 NLR is an independent non-profit organisation that provides technological support to aerospace industries, to operators of civil and military aircraft, of airports and of ATC systems, to authorities and to international organisations, all over the world. NLR employs a staff of about 900 in two main establishments, one in Amsterdam and one in the Noordoostpolder.

NLR gained experience in the field of planning and scheduling techniques in several projects, related mostly to the (dynamic) planning and scheduling of air traffic, the design of aircraft, and in command and control.

This company profile of NLR will focus on one of the areas of interest in which planning plays an important role: Air Traffic Management.

1.1 Air Traffic Management Planning

Due to the rapid growth of air traffic, many of the world's busiest airports are operating at their capacity limits. Currently, around of 20% of the world's major airports are operating near saturation for most of the day. A further 50% is operating near saturation at peak hours.

Measures being taken to alleviate those problems include better use of existing infrastructure, all weather and night-time operations, bigger aircraft, additional runways within the perimeter of existing airports and new airports. Many of these measures include the design, simulation and validation, and operational introduction of new concepts, processes and tools. Use of tools for traffic planning is one of the measures being investigated by NLR. Airport traffic management planning is a relatively new development. Benefits from introducing planning at airports are increased efficiency, better situational awareness, and reduced workload of personnel.

A possible way to divide planning tasks in Airport Traffic Management (ATM), based on current division of work in the control tower, is the following:

- Runway arrival planning.
- Runway departure planning.

- Surface movement planning, e.g., planning of the order of aircraft at aircraft gates or planning of aircraft moving from an aircraft stand to a runway along a taxi way.
- Flow planning, e.g., planning of an optimal route from one airport to another.

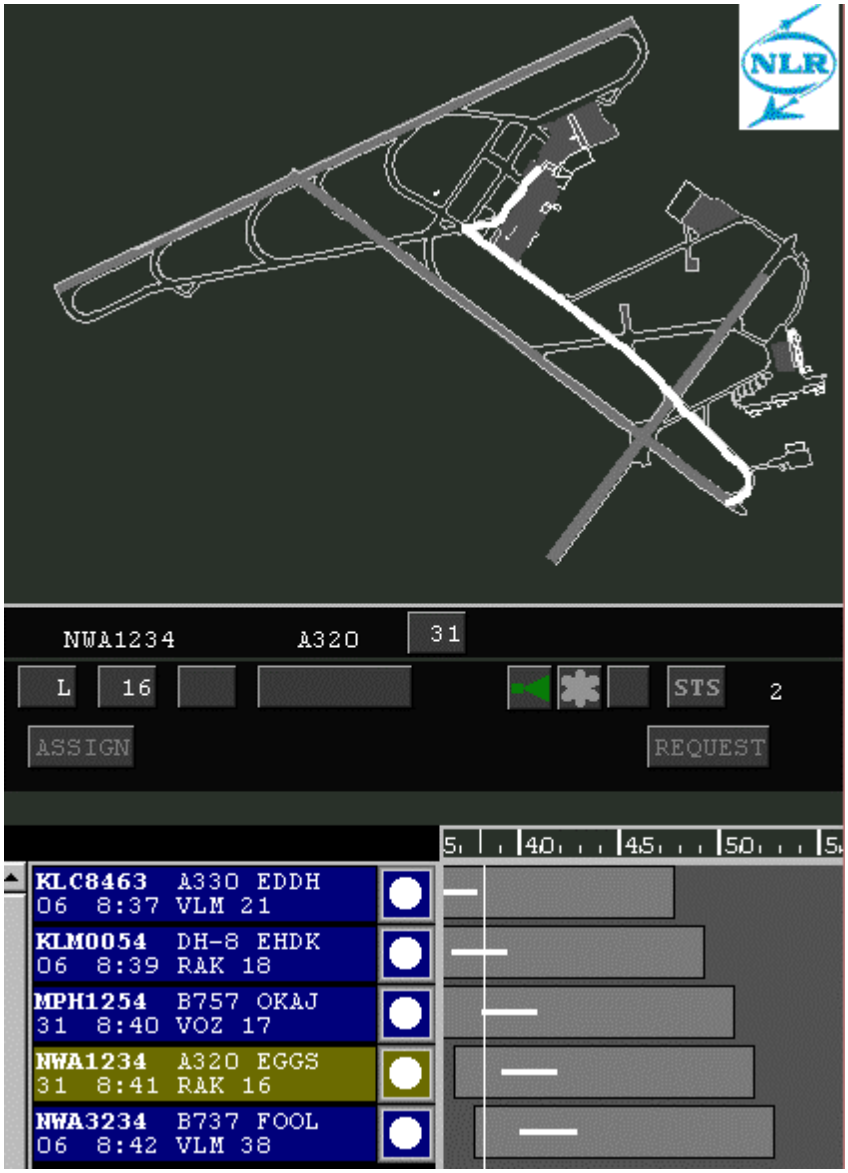

Figure 1: Planning and visualisation of departure management operations

Several controllers at the airport handle these tasks. When aircraft arrive, runway arrival planning is needed. After the aircraft has landed, its taxi route to the apron will be planned as well as its gate. Once the aircraft is ready to depart again, the start-up and pushback planning becomes in play, after which the allocation of the runway, its taxi route to the runway, and the departure sequence (see Figure 1) will be planned. When leaving the airport area each aircraft must have a route plan that will guide it from one airport to another.

In ATM, re-planning is inevitable. Re-planning can be used off-line, although it appears in most cases on-line. One can not predict every pre-condition in highly dynamic environments such as airports. Therefore, a final plan can only be determined just before the moment of performing a certain task. Although off-line planning can be as complex as on-line planning, on-line planning is more challenging because it has to be performed in a hard real time environment.

1.2 Collaborative Decision Making and Planning

Combining several activities to reach a common goal is known as Collaborative Decision Making (CDM). More specifically, it refers to the process of structuring decisions in order to maximise the overall effectiveness of a collection of processes. From this perspective, a collection of processes is more co-ordinated if, overall, they perform better on some measure of performance (e.g. efficiency and/or quality).

In ATM planning, CDM is provides the means to structure the planning activities of controllers, pilots, aircraft handlers, airport authorities, etc. CDM in ATM is illustrated by Figure 2. CDM is a necessary idea to reach the maximum result of planning in ATM and can be seen as a meta-level planning activity that incorporates all other planning activities.

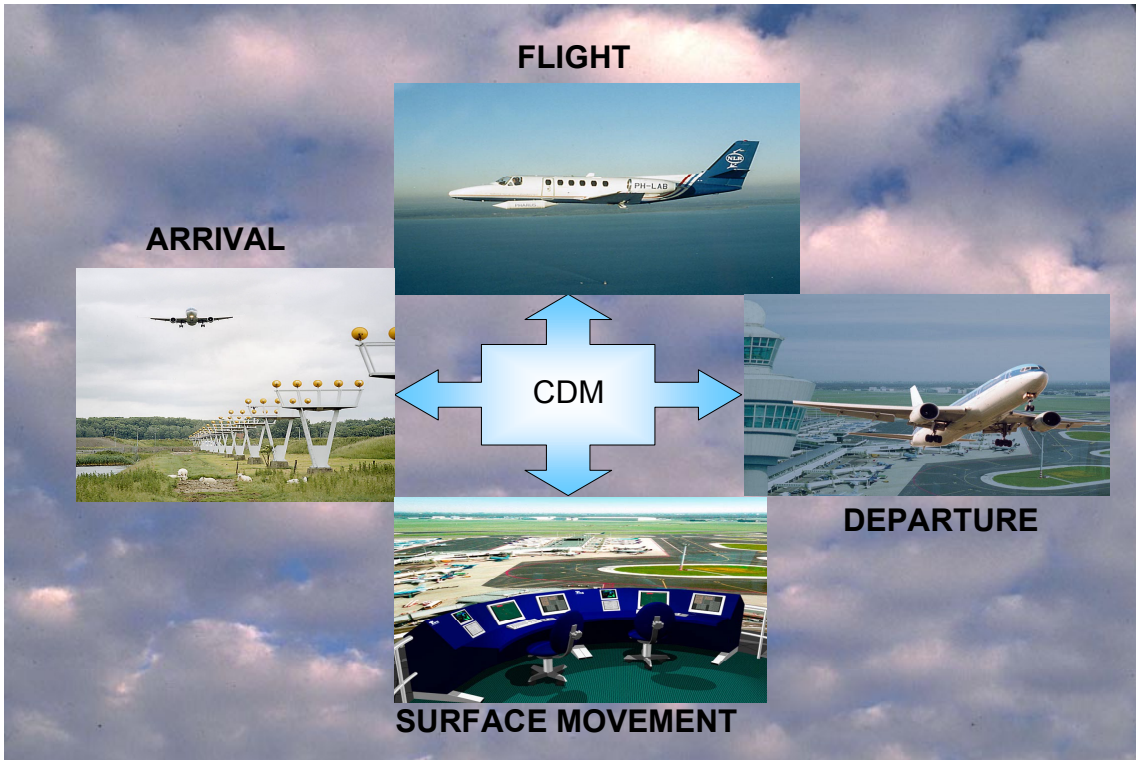

Figure 2: CDM in ATM

1.3 Examples of ATM projects at NLR

1.3.1 MANTEA

The main MANTEA (MANagement of surface Traffic in European Airports) objectives for traffic management at airports were to achieve maximum capacity while maintaining safety at the highest possible level. The planning tasks were not handled as independent tasks, but as a CDM task, in which several airport controllers were involved. The aim was not only to support airport controllers, but pilots and drivers of other moving vehicles as well. In addition, integration with en route air traffic needed to be achieved. Constraints played an important role in describing this complicated set of co-operative and co-ordinating tasks.

The MANTEA Airport Departure Sequencer (MADS[i]) tool provides an on-line decision support function that has been designed to achieve optimal throughput at a runway, to reduce controller workload, and to reduce the overall number of delays, even under adverse weather conditions.

Planning of departure sequences can be decomposed into runway (entry) allocation, SID (Standard Instrument Departure) allocation, and the application of specific airport procedures (such as the take-off after procedure). The objective of a runway departure sequencing function is to establish an optimal sequence in which aircraft can depart from available runways and to plan their initial climb phase. Numerous technical and operational constraints restrict the usage of runways, such as separation criteria, departure time slots, environmental constraints, and aircraft performance limits.

1.3.2 LEONARDO

The main objective of LEONARDO (Linking Existing ON ground Arrival and Departure Operations) is to define and demonstrate the feasibility of integrating airport planning and management tools. This objective is achieved by performing an initial operational integration of existing tools for arrival and departure planning management, together with those derived from the planning and routing function of the ground movement. The management and planning systems at airport will be experimentally implemented under real operating conditions in a tower research simulator at NLR. The results of the operational assessment of the co-operation between arrival, ground movement, and departure planning provides a quantifiable measure of the benefits in terms of the safety, capacity, and efficiency of the system.

Three concepts are defined for integrating arrival, ground and departure planning and management tools:

[i] More information can be found at http://www.nlr.nl/public/facilities/ technology.html

1. Improving exchange of information between the existing planning and managing software.
2. Improving co-ordination between the existing planning and managing software.
3. CDM, through full co-operation between planners.

In LEONARDO, CDM is implemented following a multi-agent approach.

1.4 Other NLR work in planning and sequencing

NLR participates in other ATM-Projects[ii] with on-line and off-line planning aspects and CDM, such as AATMS, AIRPORT-G, BETA, DAVINCI, and PHARE.

NLR is also involved in other planning projects in many different application domains for example aircraft design, military command and control, on-board pilot decision support, and space automation and robotics.

1.5 Contact information

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[ii] More information can be found at http://www.eurocontrol.be/ardep-arda/servlets/SVLT002

Appendix A The article as it appeared in the newsletter

Newsletter of the
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in
AI Planning

Issue No.3

http://www.planet-noe.org

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Links

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- http://www.sztaki.hu/sztaki/ake/ai/
- http://www.sztaki.hu/conferences/ieaaie2001/
- http://www-lag.ensieg.inpg.fr/~vimims/main.htm

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ARTICLE

The National Aerospace Laboratory (NLR)

Author: **R.R. Seljée, H.H. Hesselink**

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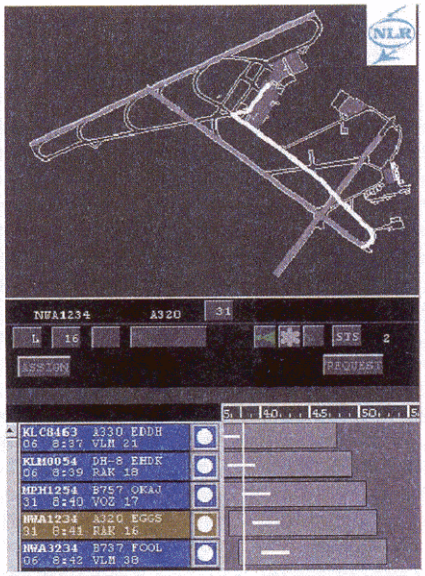

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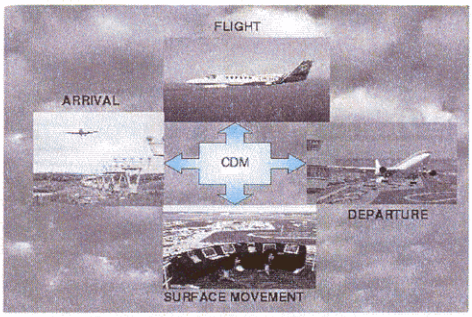

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ARTICLE

Planning & scheduling methodologies to improve iSOCO products

Author: **A. Reyes-Moro, R. Benjamins, T. Espinosa, and A. González**

Abstract

In this short communication, we introduce iSOCO as a leading Spanish company that applies Agent Based technology and AI methods to help companies to streamline their business processes within the scope of the digital economy. We also describe two main iSOCO service offerings: aggregation and e-sourcing and discuss how Planning & Scheduling methodologies can be applied to improve performance and reliability of their related products.

1. About ISOCO

iSOCO is an SME founded in July 1999 as a spin-off company of the Artificial Intelligence Research Institute (IIIA), which belongs to the Spanish Council for Scientific Research (CSIC). The company has rapidly grown to 140 employees, distributed in three offices: Barcelona, (head-quarters), Madrid and Valencia. iSOCO is mainly formed by people holding degrees in Software Engineering. About 20 people are currently pursuing their PhD and 7 people hold a PhD. People come from several international research centers, universities, and companies. Recently, iSOCO has created an innovation center (iSOCOLab) to proactively investigate new technology trends and developments that will help to deliver better services to our customers.

iSOCO closed a first round of financing of almost 15 million € in October 2000. BtoBFactory, a daughter company of BSCH (leading bank in Spain), is the leading investor. BCNEmprèn, a local venture capital company, has a small participation.

iSOCO provides end-to-end solutions for the digital economy, and has developed complex e-commerce

[3]More information can be found at http://www.eurocontrol.be/ardep-arda/servlets/SVLT002